Examiner's restriction requirement, and therefore claims 1-13, which have been withdrawn from consideration by the Examiner as being drawn to a non-elected invention, have been cancelled without prejudice to Applicant's right to prosecute this subject matter in a divisional application.

Claims 14, 18, 22, and 25 have been amended, claim 26 has been cancelled, and new claims 27-34 have been added. In view of the above amendments and the following remarks, it is respectfully submitted that these claims are allowable.

Claims 14-26 stand rejected under 35 U.S.C. § 103 as unpatentable over Egloff (U.S. No. 1,904,362) in view of Bjorkholm (U.S. No. 3,617,936) on grounds that "Egloff discloses a process of hydrocarbon conversion which includes taking hydrocarbon gases, heating them, introducing said gases into a container of reduced pressure and irradiating with ultraviolet (col. 1, lines 12-25)." The Examiner further states that although Egloff does not disclose an OPO, "it would have been obvious to one of ordinary skill in the art to incorporate the OPO of the Bjorkholm reference with the Egloff reference because Bjorkholm discloses that the OPO is a sufficient radiation source which can be tuned to any 'desired' frequency." It is respectfully submitted that the Examiner's grounds for rejection are incorrect.

Egloff shows a system which heats and pressurizes the gases within a heating element 26 to a temperature within the range of 1200° F to 1850° F, and at a pressure between 200 and 400 psi. (Page 2, lines 49-65.) The "highly heated hydrocarbons" (page 2,

line 91) are then introduced into a chamber 30 and subjected to a mercury light or other source of ultraviolet rays within the chamber.

Egloff teaches a system which suffers from the problems addressed by the present invention. Egloff teaches the input of a significant amount of heat (to reach a temperature of 1200 to 1850° F) prior to subjecting the gases to UV. This type of thermally-driven reaction is inefficient, because a relatively large amount of thermal energy is required to drive the reaction. (See page 14, lines 19-21 of the present specification.) Therefore, Egloff, which shows no recognition of the problems of inefficiency associated with such thermally-driven reactions, cannot be said to suggest the solution of the present invention.

With the method of the present invention, on the other hand, because the output of the optical parametric oscillator is selected to match at least one absorption band of the molecular substance, as recited in independent claims 14, 27 and 32, there is no need for the input of such additional thermal energy to drive the reaction. Rather, the predetermined wavelength of radiation directly promotes vibrations of the molecular substance near the predetermined wavelength, forming a peak in the vibrational distribution of the molecular substance at that wavelength, thus enhancing the reactivity of the molecular substance. (See, e.g., page 14, line 22 through page 15, line 10 of the present specification.)

The use of an optical parametric oscillator/laser (OPOL), as

recited in new independent claim 34, for example, is particularly advantageous because the output of the OPOL can be precisely and efficiently tuned to the absorption band(s) of interest. For instance, in converting methane to ethane and other higher hydrocarbons, the output of the OPOL can be tuned to both the primary absorption band (3.313 microns) and the molecular overtone (1.665 microns) to efficiently induce vibrational excitation of the methane molecules and cause dissociation, without the input of substantial thermal energy as taught by the prior art systems, such as in Egloff.

Bjorkholm, on the other hand, shows a singly resonant optical parametric oscillator, the output of which can be pulsed at a predetermined frequency to a "high degree of accuracy". Bjorkholm, however, like Egloff, shows no recognition of the inefficiency problems of thermally-driven reactions. Since there is no teaching in the prior art of addressing the inefficiency problems of thermally-driven reactions (as taught by Egloff), nor is there otherwise a teaching to replace the UV lamp of Egloff with the SRO of Bjorkholm, it cannot be said it would have been obvious to combine Egloff with Bjorkholm, as suggested by the Examiner.

Moreover, even if these references were combined as suggested by the Examiner, the resulting combination still would not teach the method of the present invention, as recited in amended independent claim 14 and new independent claims 27 and 32. To the contrary, Egloff teaches the input of a significant amount of thermal energy (to heat the gas to 1200 to 1850° F). Bjorkholm,

on the other hand, does not teach one of ordinary skill in the art to remove the heating step taught by Egloff.

Accordingly, if Egloff and Bjorkholm were combined as suggested by the Examiner, there still would be no teaching or suggestion to tune the output of the optical parametric oscillator to at least one absorption band of a molecular substance, as recited in amended independent claim 14 and new independent claim 32. Nor would there be a teaching or suggestion to tune the output of the optical parametric oscillator to a predetermined wavelength corresponding to at least one absorption band of the molecular substance, and altering the vibrational distribution of the molecular substance, as recited in new independent claim 27. Because under Egloff's method the gas is highly heated to a temperature of 1250 to 1850° F, there would be no need to tune the output of the optical parametric oscillator to a specific wavelength, as recited in these independent claims. Rather, because Egloff teaches that the molecules should be heated into an excited vibrational state by the input of substantial thermal energy, radiation anywhere within the ultra violet region is sufficient to achieve dissociation. There is no teaching in the prior art to match the output of an optical parametric oscillator or optical parametric oscillator/laser to at least one absorption band of a molecular substance to dissociate the molecular substance, as recited in these independent claims.

Accordingly, it is respectfully submitted that amended independent claim 14 and new independent claims 27 and 32 are

unobvious over Egloff in view of Bjorkholm. Because claims 15-25 and new claims 28-31 and 33-34 each depend from either claim 14, 27 or 32, it is respectfully submitted that these claims are also unobvious in view of the prior art references of record for at least the same reasons.

Claim 17 also stands rejected under 35 U.S.C. § 103 as unpatentable over Egloff in view of Bjorkholm, and further in view of Lauer (U.S. No. 3,274,087), on grounds that it would have been obvious to incorporate the teaching of Lauer with Egloff and Bjorkholm because "Lauer discloses a method for 'hydrocarbon conversion' using light in the ultra violet region". It is respectfully submitted that the Examiner's grounds for rejection are incorrect.

Lauer shows a process which subjects a mixture of methane and sulfur dioxide to intense flash irradiation with ultraviolet light. There is no teaching or suggestion of employing radiation of a specific wavelength, let alone selecting at least one wavelength corresponding to at least one absorption band of a molecular substance of interest, as recited in amended independent claim 14 and new independent claims 27 and 32. To the contrary, Lauer teaches the use of radiation anywhere within the ultraviolet region, and thus cannot be said to suggest the method of the present invention.

It is therefore respectfully submitted that claim 17 is unobvious in view of Egloff, Bjorkholm, and Lauer, either taken individually or in combination, for at least this reason.

With respect to claims 22, 24, and 25, it is respectfully submitted that these claims do not simply recite optimum process parameters discovered through routine experimentation, as suggested by the Examiner. More specifically, with respect to claim 22, none of the references of record teach or suggest a two-stage process, wherein there is a second radiation chamber for dissociating any of the first molecular substance not dissociated in the first chamber. Nor do any of the references teach a recirculation step in such a method, as further recited in claim 24.

With respect to claim 25, none of the references teach or suggest employing radiation within a specific wavelength of 3.0 microns for converting methane to ethane. To the contrary, the references of record teach the use of radiation anywhere within the ultra violet region. Because the references of record do not recognize the use of this specific wavelength (which corresponds to an absorption band of methane; see page 7, lines 1-6 of the present specification), they require the input of substantial energy to drive the reaction. This is a significant disadvantage with respect to efficiency, and is overcome by the method of the present invention. Accordingly, it is respectfully submitted that the recitation of 3.0 microns is not simply the result of routine experimentation, but is selected specifically to match an absorption band of methane, and thus cause dissociation without the input of the levels of thermal energy required by the prior art methods disclosed in the references of record.

It is therefore respectfully submitted that claims 22, 24 and

25 are unobvious in view of the prior art references of record for at least these reasons.

The undersigned has obtained complete copies of the Bjorkholm patent (U.S. No. 3,617,936) and of the Legan patent (U.S. No. 4,045,316) within the past three months, copies of which are enclosed. It is respectfully submitted that the Examiner indicate consideration of these references by returning a copy of the enclosed form PTO-1449 with initials or other appropriate marks.

It is respectfully submitted that claims 14-25 and new claims 27-34 are allowable in view of the prior art references of record. All issues raised by the Examiner having been addressed, an early action to that effect is earnestly solicited.

Respectfully submitted,

Mark D. Giarratana, Reg. No. 32,615
Attorney for Applicant
KRAMER, BRUFSKY & CIFELLI, P.C.
181 Old Post Road
P.O. Box 59
Southport, CT 06490
(203) 255-8900

Date: March 4, 1993

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to: Commissioner of Patents and Trademarks, Washington, D.C. 20231 on MARCH 4, 1993

(Date of Deposit)

SHARON MICHALEWICZ

Name of person making deposit

Sharon Michalewicz

Signature

MARCH 4, 1993

Date of Signature